A particle moves along a coordinate line, where its position at time $t$ seconds, for $t \geq 0$, is given by $x(t) = -t^2 + 4t + 5$ feet. Note that the vertex of the parabola is at $t = 2$. Find the position, velocity, speed, and acceleration at time $t = 2.5$, and the total distance traveled from time $t = 0$ to $t = 2.5$.

1. position: $8.75$
2. velocity: $4.25$
3. speed: $4.25$
4. acceleration: $13$
5. distance traveled from $t = 0$ to $t = 2.5$: $\int_0^{2.5} |v(t)| \, dt$

6. Find the total distance traveled time $t = 0$ to $t = 5$ seconds.

7. A particle moves along the $x$-axis so that at time $t \geq 0$, its position is given by $x(t) = \frac{4}{3}t^3 - 14t^2 + 49t - 53$. At what time $t$ is the particle at rest? 

(A) $t = 1$ only 
(B) $t = 3$ only 
(C) $t = \frac{2}{3}$ only 
(D) $t = 3$ and $t = \frac{7}{2}$ 
(E) $t = 3$ and $t = 4$

8. A particle moves along the $x$-axis so that at time $t \geq 0$, its velocity is given by $v(t) = 5 - 4.9 \sec^2(5t)$. What is the acceleration of the particle at time $t = 3$? 

(A) $-32.016$ 
(B) $-0.677$ 
(C) $19.053$ 
(D) $44.185$ 
(E) $72.682$

9. A particle moves along a horizontal path so that at time $t \geq 0$, its velocity is given by $v(t) = \sin(0.15t^3 + 1)$. How many times does the particle change directions on the interval $0 \leq t \leq 5$? 

(A) Two 
(B) Four 
(C) Five 
(D) Six 
(E) None
10. A particle moves along a sky with the velocity $v(t) = e^t \sin t$. How many relative extrema does the particle experience during the first ten seconds?

- (A) One
- (B) Two
- (C) Three
- (D) Four
- (E) Five

11. The position function, $x(t) = -4.905t^2 + v_0t + x_0$, is the height of the object, measured in meters, at time $t$ seconds. If an explosion on the top of a 50-meter tower causes debris to rise vertically with an initial 72 m/s, then

(a) Find the velocity of the object at time $t = 3$.

(b) Find its maximum height.

(c) Find the velocity when the object is at a height of 32 meters.

(a) $v(t) = M_a \sin \theta = -9.81(3) + 72 = 72$ m/s

(b) $v(t) = 0 \Rightarrow -9.81t + 72 = 0 \Rightarrow t = 7.3294$ s

(c) $x(t) = -4.905t^2 + 72t + 50$

\[
\begin{align*}
\text{Max } x(t) & = \frac{x''(t)}{x'(t)} \\
& = \frac{-9.81}{0} \\
& = \infty
\end{align*}
\]

\[
\begin{align*}
v(t) & = ? \text{ when } x(t) = 32 \\
32 & = at^2 + bt + c \\
& = 0 \\
& \Rightarrow t = \frac{-b}{2a}
\end{align*}
\]

\[
\begin{align*}
x''(t) & = 2 \quad x'(t) + b = 0 \\
& = 0 \\
& \Rightarrow \frac{b}{2} = -16
\end{align*}
\]

\[
\begin{align*}
-4.905t^2 + 72t + 50 & = 32 \\
t & = -2.4888, 14.9247
\end{align*}
\]

\[
\begin{align*}
v(14.9247) & = -74.412 \text{ m/s}
\end{align*}
\]
12. A particle moves along the y-axis so that its velocity $v$ at time $t \geq 0$ is given by $v(t) = 1 - \tan^{-1}(e^t)$. At time $t = 0$, the particle is at $y = -1$. (Note: $\tan^{-1}x = \arctan x$)

(a) Find the acceleration of the particle at time $t = 2$.

(b) Is the speed of the particle increasing or decreasing at time $t = 2$? Give a reason for your answer.

(c) Find the time $t \geq 0$ at which the particle reached its highest point. Justify your answer.

\[ a(2) = v'(2) = -1.133 \]  
\[ v(2) = -0.436 \]  
Speed is increasing at $t = 2$ because $a(2) < 0 \Rightarrow v(2) < 0$.

\[ \text{Max position:} \]  
\[ p(0) = 0 \]  
\[ v(t) = 0 \]  
$t = 0.44302272$ sec.
<table>
<thead>
<tr>
<th>ANSWERS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 8.75</td>
</tr>
<tr>
<td>2) -1</td>
</tr>
<tr>
<td>3) 1</td>
</tr>
<tr>
<td>4) -2</td>
</tr>
</tbody>
</table>